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USE OF REMOTELY CONTROLLED UNDERWATER VEHICLE (R. O. U. V.) AS A SCHOOL LEARNING TOOL

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ABSTRACT

This article presents the construction and use of a Remotely Controlled Underwater Vehicle (ROUV) equipment with recycled and reused materials to visualize the aquatic environment obtaining images to enrich geography classes and correlated subjects such as biology and physics, because the interdisciplinarity is crucial for the construction of knowledge, arousing in the student, in a significant way, the interest in science in a practical way, using the natural coastal environment as a classroom, in addition to showing the reuse of discarded materials. With an academic character, the article is based on physical and mathematical theories besides the basic principles of electronics and robotics that enabled its construction and application of the vehicle in internal and external environments, seeking a greater interaction of the student with the new technologies, teaching, and the environment. This article aims to build a Remotely Operated Underwater Vehicle (ROUV), allowing its use in sheltered ocean waters, rivers and lakes, in order to visualize the aquatic environment, registering images and videos to relate them to the school content and awakening the interest of the student to learn through the practice the theoretical concepts applied in the subject of high school geography, studying the forms of marine relief, as well as the deposition of sediments and their movement during the seasons.

KEYWORDS: ***Remotely Operated Underwater Vehicle, Inter-Disciplinarity, Recycled Materials & Learning***

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Original Article

INTRODUCTION

Throughout history, it has been observed that human beings have made great achievements in the submarine exploration of our oceans and seas, since approximately 70% of the terrestrial surface is covered by water, forming oceans, seas, rivers and lakes, the source of a great diversity [1]. An environment to which the human being is not naturally adapted, however, it can extract several subsistence and commercial resources, knowledge about marine scientific research, tourism and leisure potential, such as autonomy and apnea diving, and also as a tactic with military submarines during periods of world wars.

The fascination of the blue immensity and the organisms that live there also contributes to these explorations, and large reservoirs of oil and gas have recently been identified deep on the ocean floor.

It is widely known that the marine environment has great secrets to be unveiled and such secrets need to be known so that people can value this environment, protecting it from pollution, uncontrolled extraction, and other factors that destroy marine ecosystems.

For many years our oceans have been exploited inappropriately and without concern for the preservation of various animal and plant species, simply the resources were taken away by people who use these environments as a means of subsistence.

Over time this exploitation has increased considerably, leading to some species on the brink of extinction, such as the free-range whale and sea turtles, among others, with trawls and other methods that fish for several species that have no commercial value, but have a large importance in the food chain.

However, one can observe the concern of a part of the society with this environment, seeking alternatives to minimize the impact caused by the disordered exploitation. They are people of the scientific environment who use concepts, theories, methods, experiments, among others, to explain certain causes and consequences of phenomena related to the marine environment.

To accomplish this feat, manned or unmanned vehicles are used as an aid. First came the manned vehicles known as submarines, with varying dimensions according to use and crew. Subsequently, the unmanned submersible vehicles remotely controlled R.O.U.V. (Remotely Operated Underwater Vehicle), and autonomous submersible vehicles A .U. V. (Autonomus Under Water Vehicle) [2].

Dimitri Rebikoff (1950) developed the first unmanned vehicle known as "Poodle" to record photographic images published in his book "Underwater Photography" (1965), and describes that Remotely Operated Underwater Vehicle comprises a submersible vehicle operated remotely by a person in the land or on board a vessel [3-4].

In recent decades there has been an increase in the use of unmanned vehicles for underwater research due to increasing marine industrial activity at great depths.

However, there are several application possibilities of R.O.U.V. to didactic aid in the subjects of high school, such as Geography and Biology, in order to enable a better learning of the students.

The use of vehicles, such as R.O.U.V.s, allows integrating diverse data sources through the acquisition of images of marine flora and fauna, which help students to learn in different subjects, enabling a multidisciplinary process. The analysis of the images also allows us to express the magnitude of the impact of human action on the marine environment, thus providing the basis for a social-environmental discussion at school, allowing students to become aware.

In view of this reality, this article aims to build a Remotely Operated Underwater Vehicle (ROUV), allowing its use in sheltered ocean waters, rivers and lakes, in order to visualize the aquatic environment, registering images and videos to relate them to the content school and awakening the interest of the student to learn through practice the theoretical concepts applied in the subject of high school geography, studying the forms of marine relief, as well as the deposition of sediments and their movement during the seasons. For academic purposes and built with reused materials, aiming at a low cost for its manufacture, this vehicle involves several areas of knowledge to work properly and present good results.

MATERIALS AND METHODS

In the development of the vehicle, different steps were employed in order to result in a practical, inexpensive and functional equipment to aid in the learning process of the students of the Geography subject, as well as other subjects of the high school of State Schools of the municipality of Itajaí.

In choosing the steps, factors such as the objective of the article, the availability of recyclable materials on an adequate scale and the feasibility of execution from the available equipment were taken into account.

The construction of the equipment began in July 2014 and was based on the basic concepts of mechanics and physics as well as social, environmental reuse of materials such as PolyEthylene Terephthalate (PET) bottles, pool buoys,

polyvinyl chloride tubes (PVC), electric motors with 12 volt voltage, a submersible camera and an umbilical cord.

The stabilization structure of the vehicle was constructed with the PVC pipes on the sides and with a PET bottle in its central part. Inside the PET bottle, the swimming pool buoys were inserted to allow the immersion and immersion of the vehicle.

The propulsion of the vehicle was made possible by the installation of small electric motors of residential printers. On the sides the motors aim to direct to the left and to the right and the rear motor has the function of moving it forwards and backwards.

To record the images, a submersible camera was fixed to the top of the PET bottle.

Al ready to pilot the vehicle was developed a control panel connected to the R. O. U. V. By means of an umbilical cord, composed of electric wires and air hoses.

The area of data collection through R. O. U. V. was based on the ease of access of teachers and students, admitting the use, in the testing phase, in swimming pools and later in coastal and reefs of the region of Itajaí, being able to observe the relief, fauna and marine flora.

Activities were carried out with R. O. U. V. In the classroom and on the field. In the theoretical classes in the classroom were worked the basic concepts related to the subjects to be investigated, such as relief, flora, fauna, ecology, sustainability and buoyancy.

The fieldwork for imaging was performed in 2016 with observations with an average duration of 45 minutes each. For the planning of the activities the climatic and tide conditions were observed, in order to allow greater visibility in the water with less turbidity.

The images obtained during the field activities was edited and presented again in the classroom to discuss the aspects observed during the use of R. O. U. V.

The following criteria were used to measure learning:

- Application of the concepts treated by the subject in the discussions or in the textual production;
- Objectivity in the elaboration of the proposed practical activities;
- Quantitative participation;
- Qualitative participation;
- Appropriation and assimilation of knowledge.

Figure 1 shows on the map the location chosen for the accomplishment of the activity in the field and such choice was made because it is a sheltered place and with good visibility. The chosen location is located on the beach of Saudade, in the municipality of Penha (SC). It is a rocky coast with a small sandy strip, sheltered from the great waves and with little circulation of bathers.

Figure 1: Study Area

RESULTS AND DISCUSSIONS

The development of R.O.U.V. (Figure 2) began with the collection of recyclable materials and possible to be reused in the making of the equipment.

Subsequently a PVC pipe of the appropriate size and with the necessary openings was cut so that the water could enter the ballast, with the upper part open in the longitudinal direction, slightly waved for fixing the chambers, this part being the main body of ROUV.

The housing of the air chambers in the central part of R.O.U.V. It was possible with the aid of PET (PolyEthylene Terephthalate) bottles coupled to the tube, where the water infiltrates making it heavier than the water and thus immersion occurs. When inflated with compressed air, the water is expelled from the bottle making it lighter than water, and thus emersion occurs. This process was only possible by the presence of an air hose that is connected to an air compressor or pump.

The secondary tubes that serve to stabilize and drive the vehicle were cut at 45 degree angles at the ends to improve performance in the water and then glued together to form a rigid and lightweight structure.

Due to the movement of the equipment in the aquatic environment it needs handling and for this to be possible two PVC tubes with 40 mm in diameter were coupled on the sides and a 40 mm tube in the lower part where there is a motor responsible for the direction and to improve stability.

The tubes were fastened with water-resistant adhesive, reinforced with high strength tape to support the movements during the operations and guarantee the balance of the vehicle without the aid of the motors.

The hose responsible for the passage of air between the R.O.U.V. and the compressor was also studied for good performance, where it was verified that the silicon hose was efficient for this first moment, however, it is believed that it does not support greater depths due to its expansion or flattening.

The recording of aquatic images was possible through the use of an Emerson Action Cam video camera equipped with a watertight box that allows to film for a long period.

The connection between the R.O.U.V and the control center was carried out by means of flexible 2.5 mm electric cables, one positive and one negative, with metallic pressure connectors to facilitate the assembly of the equipment at the point of use.

The battery responsible for the vehicle's power source has a 12-volt, rechargeable electric charge and is connected to the control center connected to the R.O.U.V by an umbilical cord of 7.5 meters. This cord is composed of flexible

electrical wires and an air hose that inflates the air chambers.

With all components properly installed the equipment has been finalized and can be tested in water to perform its function of submersion and immersion, capturing aquatic images that were studied to enrich the classes.

Figure 2: R.O.U.V. Developed

The applicability of the equipment in the teaching learning process could be tested in several activities carried out during the development of R.O.U.V. Such as, for example, in the application to children's education and Specialized Educational Assistance (AEE) during the REDITEC 2016 event in Vitória - ES (Figure 3 and 4), classroom activities (Figure 5 to 8) and activities (Figure 9 to 11).

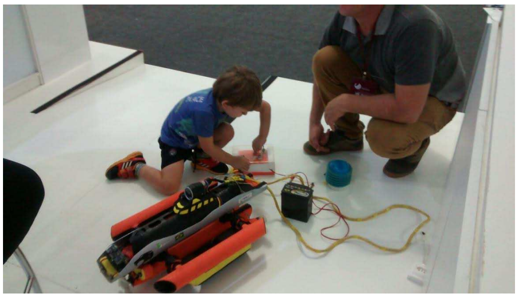

Figure 3: Heating Energy Demand in Piglet's Production Farms

Figure 4: Booth of the Federal Institute of Santa Catarina and Ministry of Education in REDITEC 2016

During all stages of construction of R.O.U.V. The students (Figure 5) of the High School were involved in order to present the concepts of recycling and reuse, as well as to work on the manufacturing processes and materials used.

Figure 5: Initial Phase of Construction of the Vehicle in the Classroom with the Participation of Students

Much of the project was carried out in the classroom, with the content inserted in the semester planning of the course, taking advantage of it as a pedagogical tool. Students participated in the construction in any way, either with suggestions, bringing materials such as motors, batteries and light bulbs, or handling the equipment in pools in the school unit during science fairs (Figure 6).

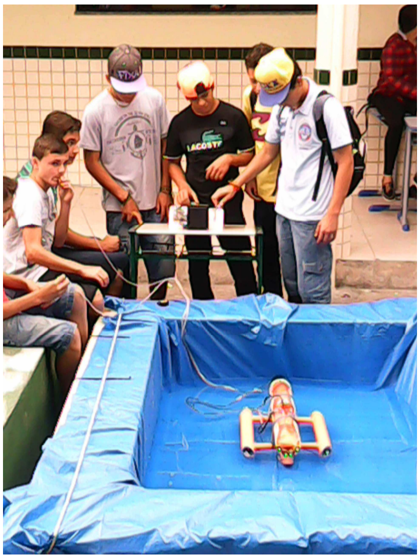

Figure 6: Drive Ability Tests in Swimming Pool with Students of the 2nd Year of High School during the Science Fair of the Alexandre Guilherme Figueredo Elementary School

The students' involvement (Figure 7) with the project was extremely motivating, since they showed an interest in the equipment and its applicability. During the presentation of the vehicle, one can observe the students' interest in understanding the equipment, through several questions and the handling of the vehicle controls, enabling an improvement in the teaching-learning relationship, especially when working the Marine Environment in an integrated way.

Initially the students presented some resistance because it was a different equipment, not very common, but with

the course of the lesson they realized a possibility to learn from the practice and they got involved in excellent discussions about the applicability of R.O.U.V.

In order to improve the utilization of the equipment as a school tool, it was necessary to use a laboratory so that the students had a physical space for the proposed activities, as shown in Figure 8.

Figure 7: Second Year High School Students Handling the Controls of the R.O.U.V. in the Classroom

Figure 8: Students in the Laboratory of E.E.B. Alexandre Guilherme Figueredo

The field activities were carried out on a rocky shore with a small sandy strip, sheltered from the great waves and with little circulation of swimmers on the beach of Saudade (Figure 9), in the municipality of Penha, Santa Catarina (SC).

ROUV performed its functions well, allowing the recording of images of the marine environment and the best learning of students through local activities.

Figures 10 and 11 show the images recorded by R.O.U.V, where one can observe a starfish in the middle of green algae and a juvenile mullet in a natural environment, respectively.

Figure 9: Practice with High School Students

Figure 10: Starfish on the Rocks Amid the Green Algae

Figure 11: Juvenile Mullet in Natural Environment

For the analysis of the students' learning, a continuous evaluation process was used that allowed, through the pre-defined evaluation criteria, to follow the development of the students of the second year of high school of E.E.B Alexandre Guilherme Figueredo.

One can see the greater interest of the class-based students with practical activities compared to students with classic (theoretical-only) classes. The students who participated in the practical activities with the R.O.U.V. recognized around 11% more marine species than classes with classic classes and increased attendance by 12%, as well as presented

greater motivation in the other subjects of high school in general.

CONCLUSIONS

The present article provided the students with a research tool, being used in an academic and uniting the theoretical and practical knowledge of geography.

With the planning of the activities, it was possible to apply the specific knowledge and thus to promote the scientific knowledge among the students, stimulating them with the practicalactivities and interdisciplinary form the subjects related to Marine Sciences.

Thus, an option of practical activity for the subject of geography and other preparatory high school subjects was provided, guaranteeing the school multi disciplinary and awakening in the student the desire to learn from the practice.

The students who participated in the laboratory and field activities, using the R.O.U.V., ensured greater learning, attendance, and respect for the school teachers.

The need to use new didactic-pedagogical tools and strategies is evident in order to find more effective ways of guaranteeing the expansion of the quality level in basic education and that deviate from traditional and secular teaching techniques.

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